THE ELODIE-SOPHIE ARCHIVE IN THE VIRTUAL OBSERVATORY

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ABSTRACT

The ELODIE spectrograph was the main instrument used at the 1.93m telescope of Observatoire de Haute-Provence between 1994 and 2006. It has been replaced in September 2006 by SOPHIE. Both are fiber-fed échelle spectrographs providing high resolution spectra in the optical range, optimized for precise radial velocity measurements.

The data from these instruments are archived by the producer and are available on-line since 2003. Different data-products (raw data, cross-correlation functions, extracted and re-connected 1D spectra) are distributed by the service. The system allows also on-the-fly reprocessing, to customize the wavelength resampling, adjust the resolution, normalize the spectra to a pseudo-continuum.

The access to 1D spectra is registered as a service of the Virtual Observatory (SSA).

Key words: Virtual Observatory.

1. THE ELODIE SPECTROGRAPH AND ARCHIVE

ELODIE was designed for very precise radial-velocity measurements (the discovery of the first extra-solar planet, 51 Peg B, by Mayor & Queloz (1995) was made using Elodie spectra) but has also been used for many programs in stellar physics and Galactic structure.

The spectra have a nominal resolution of R=42000. Because the spectrograph has a limited number of modes of operation and is located in a temperature-controlled room, the whole series of measurements, over the 12 years of operations, presents a remarkable homogeneity in wavelength stability, detector characteristics and processing.

The different modes of operation concern the possibility to observe or not the sky background on a separate fiber, or to observe a simultaneous arc calibration to achieve ultimate precision on the radial velocities: The best precision is about 7 m/s.

Both raw and processed data are archived and can be accessed from: http://atlas.obs-hp.fr/elodie The instrumental-flux reconnected 1D spectra are available in the VO through a SSA.

The archive is described in Moultaka et al. (2004).

A subset of 2000 spectra was used to produce the ELODIE *library* (Prugniel & Soubiran, 2001; Prugniel et al., 2007). which is flux-calibrated and designed as a set of reference stellar spectra with well measured atmospheric parameters.

2. THE SOPHIE SPECTROGRAPH AND ARCHIVE

SOPHIE is a cross-dispersed échelle spectrograph permanently located in a temperature-controlled chamber. The first light with this instrument was achieved on July 31, 2006. The spectrograph is fed from the Cassegrain focus through pairs of optical fibers, one of which is used for starlight and the other can be used for either the sky background or the wavelength calibration lamp, but can also be masked. The spectra presently cover the wavelength range 3872-6943 Å. Two separate optical fiber pairs yield two different spectral resolutions (HE and HR modes).

SOPHIE has also an online processing capability, and the archival system was part of the instrument design. It is almost automatic, which allows to reduce the efforts which were required for the archival of ELODIE.

The data-model and archival system was based on the prescriptions of the Virtual Observatory. A Simple Spectra Access service is built in the archive.

3. THE DATA ACCESS POLICY

For the ELODIE spectrograph exclusive rights to the data were granted to the PI for a period of 2 years with some exceptions being granted by the Observatory, in particular for extra-solar planet searches. For SOPHIE, the Observatory has adopted a standard exclusivity period of 1 year, with a special status for Science Verification, ToO and legacy observations which are released immediately (during the night, after the processing and control), and an extended period of 5 years for long term monitoring (like extra-solar planet searches) where after the 1st year, the data will be made available without the accurate time information.

The ELODIE archive holds over 35000 scientifically useful spectra for about 3500 objects.

4. THE ARCHIVE CONTENT & MANAGEMENT

During all the operational life of the ELODIE spectrograph, the raw and pipeline-reduced observations were saved on CD-roms, and later this collection was transfered onto magnetic discs.

The different tasks in the management of the archive are:

Organization of the archive on magnetic disks. The observations are primarily archived on CD-ROMs made manually. For SOPHIE , this task is automated but still requires supervision.

Access interface. The access interfaces (classical web interface, and VO interfaces) were built using the Pleinpot software package.

Quality control and corrections. The original observations contain numerous errors, like wrong object designations provided by the observer, wrong initialization of the telescope coordinates. Many automatic tests are performed at the time of entry into the database, but most of the detected cases have to be individually checked and corrected.

Users support. We answer between 2 and 4 questions from users each month.

The project is managed entirely by astronomers, and the total operation requires about 0.15 full time equivalent. The most demanding task is quality control.

The web interface (cgi) allows to select observations given object designations, position (cone searchs) or more elaborated constraints, like for example S/N, date of observation, name of the observer...

Then, for selected observations a variety of data products can be accessed, in particular:

The 67 extracted and de-blazed orders (S2D) presented as a 2D stacked-spectra image with wavelength dispersion relation coded in the header, and blaze function in a separate extension

The 1D spectrum (S1D) resulting from the reconnection of the orders and calibrated in *instrumental flux* (actually the flux distribution relative to the internal tungsten lamp). The associated error spectrum is in a separate extension.

The cross-correlation functions, computed at observation-time using binary masks. They allow an accurate determination of the radial velocity (corrected in heliocentric rest-frame) and give an indication about the rotation and/or duplicity of the object. They are given as 1D FITS file with correlation value *vs*. velocity.

The raw observations (scientific and calibration CCD frames) are presently not distributed for the lack of demand; the full data-reduction is complex, and the pipeline reduction is generally considered as acceptable.

The preferred data-products of the users are the 1D-spectra. They can be processed on the fly using a customizable pipeline allowing to mask (or not) the telluric absorption lines, to generate spectra normallized to the pseudo-continuum, to broaden the lines (to adapt the resolution or simulate a red-shift and velocity dispersion), to resample with a given step and wavelength limits.

The VO SSA access gives only access to the S1D in instrumental flux. It would be useful in the future to implement extension in the VOTable in order to associate the different data-products. A standardization of the description and format of order-extracted spectra (S2D) is also necessary (the present SSA standard is probably suited for distributing the cross-correlation functions). In a longer term, executing the archive's pipeline through the VO to customize the extractions would be a real progress.

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